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A METHOD FOR FORMING A FILM

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[There are no amendments to this patent.]

Claims

1. A method for forming a film, characterized by the fact that, during the deposition of a specific film onto a to-be-treated substrate, which involves passing specific reactive gases through a chamber housing the above-mentioned to-be-treated substrate, a high-pressure atmosphere is formed from an ambient-pressure atmosphere inside the above-mentioned chamber, with a specific film then being deposited onto the above-mentioned to-be-treated substrate.

Detailed explanation of the invention

Objective of the invention

Industrial application field

The present invention concerns a method for forming a film.

Prior art

In general, methods for forming a film (e.g., SiO_2 film) onto a to-be-treated substrate (e.g., semiconductor wafer) during a semiconductor manufacturing process can be roughly divided into two categories, with one category including methods in which a film is formed by directly oxidizing the silicon on the surface of a semiconductor wafer by means of heat oxidation, and with the other category including methods of deposition.

Additionally, methods of deposition include (1) CVD methods according to which specific reactive gases (e.g., SiH_4 and oxygen) are allowed to flow through a chamber, with SiO_2 being formed by the reaction of the reactive gases, (2) sputtering methods according to which SiO_2 is directly deposited in a vacuum, and (3) spin-on-glass methods according to which an alcoholic solution of an organosilane compound is applied, with SiO_2 being formed upon baking.

Among these methods for forming a film, the conventional CVD methods can be roughly divided into two categories, with one category including methods of ambient-pressure CVD according to

which deposition of a film is conducted under an ambient-pressure atmosphere, and with the other category including methods of reduced-pressure CVD according to which the deposition of a film is conducted under a reduced-pressure atmosphere. Furthermore, reduced-pressure CVD methods include plasma-CVD methods according to which plasma is used and photo-CVD methods according to which a light source, such as UV light, is used.

Problems to be solved by the invention

As described above, conventional methods of forming a film by means of CVD involve conducting a treatment of allowing specific reactive gases to act on a to-be-treated substrate (e.g., a semiconductor wafer) under an ambient-pressure atmosphere or a reduced-pressure atmosphere. These methods also include a means of preventing toxic silane gases (e.g., SiH_4) from escaping to the outside.

However, it has been desired that the film-forming speed and throughput of these film-forming methods can be improved.

The present invention offers a method of forming a film, which provides a solution to the above-mentioned problems, thereby allowing the film-forming speed to be improved in comparison with that of conventional methods.

Structure of the invention

Means to solve the problems

Specifically, the present invention offers a method of forming a film, which is characterized by the fact that, during the deposition of a specific film onto a to-be-treated substrate, which involves passing specific reactive gases through a chamber housing the above-mentioned to-be-treated substrate, a high-pressure atmosphere is formed from an ambient-pressure atmosphere inside the above-mentioned chamber, and a specific film is then deposited onto the above-mentioned to-be-treated substrate.

Action

According to the film-forming method of the present invention with the above-mentioned structure, reactive gases of an organosilane (e.g., TEOS) and ozone-containing oxygen gas are fed under pressure into a chamber housing a to-be-treated substrate, a high-pressure atmosphere is formed inside the chamber, and a specific film (e.g., SiO_2 film) is then deposited onto the to-be-treated substrate. Thus, the film-forming speed can be improved in comparison with that of conventional methods. Additionally, since an organosilane, such as TEOS is used, the serious toxicity issue related to the use of a silane is not a concern even if the above-mentioned organosilane accidentally escapes to the outside.

Application examples

Next, the present invention is described by means of application examples together with figures.

A to-be-treated substrate, such as a semiconductor wafer (3), is placed inside a chamber (2) of a CVD device (1), which is equipped with a heating plate (4) for heating the semiconductor wafer (3) and a gas-diffusion plate (5), which faces the heating plate (4).

A diffusion-plate positioning device (6) is connected to the above-mentioned gas diffusion plate (5) in such a manner that a desired distance between the semiconductor wafer (3) and the gas diffusion plate can be attained. Additionally, the gas diffusion plate (5) is equipped with openings for the treatment gases (e.g., ozone-containing gases) to be ejected and openings for waste gases to be discharged. For example, a multiple number of gas-ejecting slits (7) and waste-gas-discharging slits (8) are alternately installed.

Moreover, a pressurizing device (9) comprising a plunger pump, bellows pump, diaphragm pump or the like is connected to the above-mentioned gas-ejecting slits (7). An ozone-generating device (11), which generates ozone from oxygen fed from an oxygen-supplying device (10), and an organosilane-supplying device (12), which supplies an organosilane (e.g., TEOS), are connected to the pressurizing device (9) via flow regulators (13) and (14), respectively. Additionally, ozone-generating devices, which generate ozone by means of soundless discharge, corona discharge, glow discharge and the like, can be used as the ozone-generating device (11).

Meanwhile, the waste-gas-discharging slits (8) are connected to the plant's exhaust gas system or the like via the pressure regulator (15) and exhaust-gas neutralization device (16).

Moreover, the heating plate (4) is equipped with a multiple number of pins (18) (e.g., three pieces), which are connected to the substrate positioning device (17) in such a manner that these pins (18) penetrate through the heating plate (4), thereby providing a configuration with which the semiconductor wafer (3) can be kept on these three pins (18) during loading and unloading.

Additionally, the side of the chamber (2) is equipped with a gate mechanism (19) for loading and unloading, with a substrate-sending device (20) being installed next to the gate mechanism (19) for the purpose of loading and unloading the semiconductor wafer (3) from the chamber (2).

In this application example, the CVD device (1) with the above-mentioned configuration is used for conducting the deposition of a film (e.g., SiO_2 film) onto the surface of the semiconductor wafer (3) in a manner described below.

Specifically, the gate mechanism (19) is opened and the semiconductor wafer (3) is sent to the heating plate (4) inside the chamber (2) by means of the substrate-sending device (20). Additionally, the gas diffusion plate (5) is raised beforehand by means of the diffusion-plate positioning device (6), so that a sufficient gap is formed between the heating plate (4) and the gas diffusion plate (5).

Next, the pins (18) are raised by means of the substrate positioning device (17), so that the semiconductor wafer (3) can

be transferred from the substrate-sending device (20) onto the pins (18).

Afterward, the transporting arm of the substrate-sending device (20) is caused to move backward, then the gate mechanism (19) is closed. At the same time, the pins (18) are lowered by means of the substrate positioning device (17), so that the semiconductor wafer (3) is placed onto the heating plate (4), with the gap between the gas diffusion plate (5) and the semiconductor wafer (3) being set at the specified value by means of the diffusion-plate positioning device (6).

Next, a film-forming treatment is conducted in the following manner. The semiconductor wafer (3) is heated to the specified temperature by means of the heating plate (4). At the same time, an ozone-containing oxygen gas supplied by the ozone-generating device (11) and an organosilane (e.g., TEOS gas) supplied by the organosilane-supplying device (12) are adjusted to the specified flow rate (e.g., 3-30 L/min) by means of the flow regulators (13) and (14) respectively, then pressurized to 2-20 atm. for example, by means of the pressurizing device (9), and are ejected from the gas-ejecting slits (7) of the gas diffusion plate (5) toward the semiconductor wafer (3). At the same time, waste gas is discharged from the waste gas-discharging slits (8).

Furthermore, residual ozone in the exhaust gas is decomposed by the exhaust-gas neutralization device (16); the neutralized exhaust gas is then sent to the plant's exhaust-gas system. Also, the pressure inside the chamber (2) is maintained at the above-mentioned specified pressure (e.g., 2-20 atm) by means of the pressure regulator (15), as the above-mentioned exhaust gas is being discharged.

Accordingly, with the CVD device (1) of the application example, a film-forming treatment can be conducted under a high-pressure atmosphere, and a film can be formed at a high speed under a reaction-gas density higher than that of conventional methods. Furthermore, as the result of a higher film-forming speed, the film-forming process can be conducted at a lower temperature. Additionally, since an organosilane, such as TEOS is used, the serious toxicity issue related to the use of a silane is not a concern even if the above-mentioned organosilane accidentally escapes to the outside.

Moreover, according to the CVD device (1) of the application example, the pressurizing device (9) is installed downstream from the ozone-generating device (11). Therefore, conventional ambient-pressure ozone-generating devices can be used as the ozone-generating device (11). Also, for example, like the CVD device (1a) shown in Figure 2, the pressurizing device (9) is not used. Instead, a high-pressure oxygen-supplying device (10a), a pressure-resistant high-pressure ozone generator (11a) and a high-pressure organosilane-supplying device (12a) are used.

Effects of the invention

As described above, the present invention offers a method of forming a film, which allows the film-forming speed and throughput to be improved in comparison with that of conventional methods.

Brief explanation of the figures

Figure 1 shows the configuration of a CVD device for the purpose of describing an application example of the film-forming method of the present invention. Figure 2 shows another configuration of the CVD device of Figure 1.

(1) CVD device
(2) Chamber
(3) Semiconductor wafer
(4) Heating plate
(5) Gas diffusion plate
(6) Diffusion-plate positioning device
(7) Gas-ejecting slits
(8) Waste-gas-discharging slits
(9) Pressurizing device
(10) Oxygen-supplying device
(11) Ozone generator
(12) Organosilane-supplying device
(13) and (14) Flow regulators
(15) Pressure regulator
(16) Exhaust-gas neutralization device
(17) Substrate positioning device
(18) Pins
(19) Gate mechanism
(20) Substrate-sending device

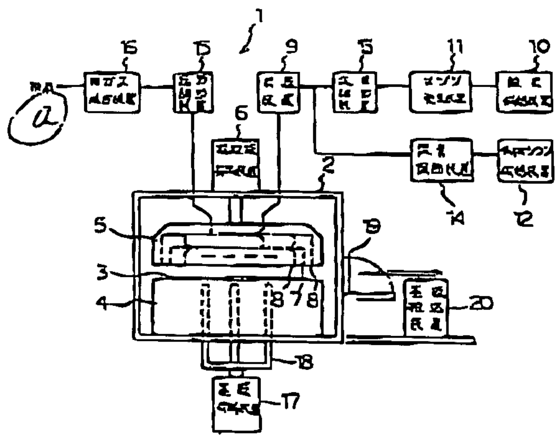

Figure 1

Key: (a) Exhaust gas
(6) Diffusion-plate positioning device
(9) Pressurizing device
(10) Oxygen-supplying device
(11) Ozone generator
(12) Organosilane-supplying device
(13) and (14) Flow regulators
(15) Pressure regulator
(16) Exhaust-gas neutralization device
(17) Substrate positioning device
(20) Substrate-sending device

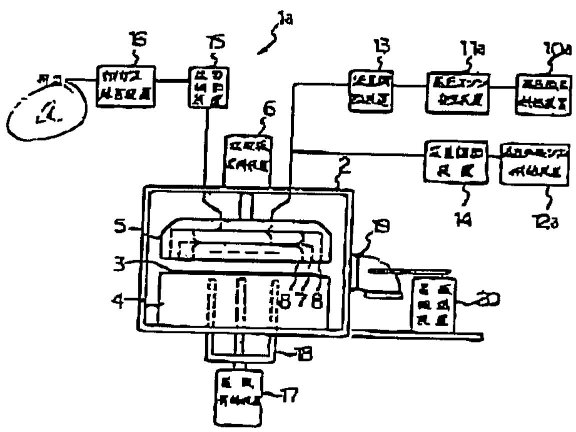

Figure 2

Key: (a) Exhaust gas
(10a) High-pressure oxygen-supplying device
(11a) Pressure-resistant high-pressure ozone generator
(12a) High-pressure organosilane-supplying device
(6) Diffusion-plate positioning device
(13) and (14) Flow regulators
(15) Pressure regulator
(16) Exhaust-gas neutralization device
(17) Substrate positioning device
(20) Substrate-sending device